

RENNER, OTTO, BOISSELLE & SKLAR, L.L.P.

1621 EUCLID AVENUE, 19TH FLOOR

CLEVELAND, OHIO 44114

(216) 621-1113

FAX (216) 621-6165

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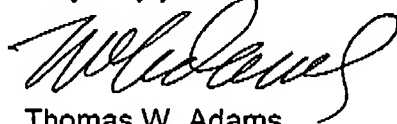
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to: Examiner Patel
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Examiner Patel:

Transmitted herewith are the translations of the Japanese references JP 59-31886 and JP 59-35694, cited in our IDS filed in approximately NOVEMBER 2001. Please let me know if there are any questions relating to this or any other matter.

Very truly yours,



Thomas W. Adams
Renner, Otto, Boisselle & Sklar

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Translation of JP Kokai Publication No. 59-31886

Translation of Japanese Laid-Open Patent Publication No. 59-31886

Application Number: 57-141493

5 Filing Date: August 12, 1982

Laid-Open Publication Number: 59-31886

Laid-Open Publication Date: February 21, 1984

Inventor(s): Ryusuke KAWANAKA, et al.

Applicant: MITSUBISHI DENKI KABUSHIKI KAISHA

10 Agent: Shinichi KUZUNO, Patent Attorney (and one other)

SPECIFICATION

15 1. TITLE OF THE INVENTION

METHOD FOR PREVENTING OCCURRENCE OF TIN WHISKER

2. CLAIMS

20 (1) A method for preventing the occurrence of a tin whisker, ordinary tin plating is provided on a base metal, after which a thin lead film of 0.05 μ m or more is formed on a surface thereof.

25 (2) A method for preventing the occurrence of a tin whisker according to claim 1, characterized in that the thin lead film is formed by electroplating, electroless plating, vapor deposition, or sputtering.

30 (3) A method for preventing the occurrence of a tin whisker according to claim 1, characterized in that a region having a high lead concentration is formed as the thin lead film by ion implantation, or diffusion.

35 (4) A method for preventing the occurrence of a tin whisker according to claim 1 or 2, characterized in that a thin film of a lead-tin alloy containing 5% or more of lead is formed as the thin lead film.

3. DETAILED DESCRIPTION OF THE INVENTION

40 This invention relates to tin plating for providing rust prevention, corrosion prevention, desirable solderability, and particularly to a method for preventing the occurrence of an intrinsic tin whisker which may cause an electric short-circuit.

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5 With tin plating, an intrinsic whisker generally occurs after one week to several years from the time of plating, thereby resulting in an electric short-circuit which then leads to an accident.

10 Conventionally, solder plating containing 1-30% of lead (lead-tin alloy plating) has been employed as plating for preventing the occurrence of the intrinsic tin whisker. Figures 1 and 2 are cross-sectional views showing a portion where tin plating and solder plating, respectively, have been provided.

15 A tin plating is provided by forming a tin plating film (11) on a base metal (13) on which a base plating film (12) has been provided, as illustrated in Figure 1. On the surface of the plating film thus obtained, an intrinsic tin whisker* [Translator's Note: Throughout this translation, the designation "whisker*" is used to indicate an occurrence of misspelling of the word "whisker" in the original Japanese text.] often occurs in
20 several days to several years, causing an electric short-circuit.

25 A solder plating is provided by providing a solder plating film, as indicated at (21) in Figure 2, in place of the tin plating film at (11) in Figure 1. No intrinsic tin whisker occurs. However, lump-like protrusions occur, which are 10 times or more bigger than the diameter of a whisker.

30 With solder plating, since the plating film consists of an alloy of lead and tin, it is necessary to maintain the content ratio between lead and tin within a certain range, whereby it is necessary to maintain the composition of the plating solution within a certain range. However, since the
35 composition of the plating solution changes as the plating process proceeds, it is necessary to constantly control the composition of the plating solution, and there are other problems such as the plating solution being expensive.

40 The present invention has been made to eliminate the drawbacks in the prior art as described above, and aims to provide a method for preventing the occurrence of a tin whisker by applying an extremely thin layer of lead on the surface of a tin plating after ordinary tin plating has been
45 provided, thereby providing effects equal to or greater than

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those which are provided by solder plating in terms of tin whisker prevention.

5 An example of the present invention will now be described. In Figure 3, (13) is a base metal, (12) is a base plating film, (11) is a tin plating film, and (31) is an extremely thin lead plating film provided on the tin plating film.

10 In the above-described example, a brass, with which an intrinsic whisker is likely to occur, was used as the base metal, and a tin plating solution containing a brightener, with which an intrinsic whisker is also likely to occur, was used for the tin plating, so as to produce a plating film having a thickness of 3 μm . Separately from this, a lead plating of 0.05-0.5 μm was provided on another tin plating film obtained under the same conditions. Among these plating films which were produced from a solution, an intrinsic whisker occurred in about one month on those for which only tin plating was provided. On the other hand, no intrinsic whisker occurred even after two years on those plating films for which a lead plating was provided on top of the tin plating. However, protrusions occurring on the solder plating film were observed. Where a lead plating was provided under a tin plating, rather than on top of the tin plating, the effect of lead plating was not seen, and an intrinsic whisker was observed as in the case of tin plating alone.

30 Thus, it was confirmed that there is an effect of preventing the occurrence of an intrinsic whisker when an extremely thin lead plating is present on a tin plating according to the present invention.

35 In another example, a lead film was produced on a tin plating to a thickness of 0.05, 0.1 and 0.3 μm by electroless plating vapor deposition, sputtering, etc. Also for these tin platings, it was confirmed that no intrinsic whisker* occurs even after about 1.5 years and that these tin platings have the same effects as those provided by the lead film formation through electroplating.

40 Moreover, in still another example, a high lead concentration layer of 0.05 μm was produced on the surface of a

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tin plating film by ion implantation, wherein no intrinsic whisker occurred after about 1.5 years. It is noted that when a high lead concentration layer is formed by diffusion, heat is used and therefore there is a temperature increase, whereby a significant prevention effect is additionally provided from the temperature increase, and it is believed that an intrinsic whisker did not occur owing to a combination of the two prevention effects.

As described above, according to the present invention, a tin plating and a thin lead film are produced separately from each other, whereby the advantages of tin plating are not lost; the control of the plating solution is easier than in the case of solder plating; and it is not necessary to use an expensive plating solution such as a solder plating solution. Therefore, the present invention is extremely effective as a method for preventing the occurrence of a tin whisker.

4. BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view illustrating a state after ordinary tin plating is provided; Figure 2 is a cross-sectional view illustrating a state after solder plating, which is considered to be effective in preventing an intrinsic whisker, is provided; and Figure 3 is a cross-sectional view illustrating a state after a lead plating film is provided on top according to the present invention.

In the figures, (11) is a tin plating film, (12) is a base plating film, (13) is a base metal, and (31) is a lead plating film.

It is noted that in the figures, the same reference numerals denote the same or equivalent portions.

Agent: Shinichi KUZUNO

Translation of JP Kokai Publication No. 59-35694

Translation of Japanese Laid-Open Patent Publication No. 59-35694

Application Number: 57-147480

5 Filing Date: August 23, 1982

Pursuant to Sec. 30(1) of the Japanese Patent Law, the subject matter was published in "Journal of Japanese Association of Crystal Growth", 1982 July, Vol. 9, No. 3 published on July 15, 1982 by Japanese Association of Crystal Growth.

10 Laid-Open Publication Number: 59-35694

Laid-Open Publication Date: February 27, 1984

Inventor(s): Ryusuke KAWANAKA, et al.

Applicant: MITSUBISHI DENKI KABUSHIKI KAISHA

Agent: Shinichi KUZUNO, Patent Attorney (and one other)

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SPECIFICATION

1. TITLE OF THE INVENTION

20 METHOD FOR PREVENTING OCCURRENCE OF TIN WHISKER

2. CLAIMS

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(2) A method for preventing the occurrence of a tin whisker according to claim 1, characterized in that the thin lead film is formed by electroplating, electroless plating, vapor deposition, or sputtering.

(3) A method for preventing the occurrence of a tin whisker according to claim 1, characterized in that a region having a high lead concentration is formed as the thin lead film by ion implantation, or diffusion.

(4) A method for preventing the occurrence of a tin whisker according to claim 1 or 2, characterized in that a thin film of a lead-tin alloy containing 5% or more of lead is formed as the thin lead film.

3. DETAILED DESCRIPTION OF THE INVENTION

This invention relates to tin plating for providing rust prevention, corrosion prevention, desirable solderabil-

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ity, and particularly to a method for preventing the occurrence of an intrinsic tin whisker which may cause an electric short-circuit.

5 With tin plating, an intrinsic whisker generally occurs after one week to several years from the time of plating, thereby resulting in an electric short-circuit which then leads to an accident.

10 Conventionally, solder plating containing 1-30% of lead (lead-tin alloy plating) has been employed as plating for preventing the occurrence of the intrinsic tin whisker. Figures 1 and 2 are cross-sectional views showing a portion where tin plating and solder plating, respectively, have
15 been provided.

 A tin plating is provided by forming a tin plating film (11) on a base metal (13) on which a base plating film (12) has been provided, as illustrated in Figure 1. On
20 the surface of the plating film thus obtained, an intrinsic tin whisker* [Translator's Note: Throughout this translation, the designation "whisker*" is used to indicate an occurrence of misspelling of the word "whisker" in the original Japanese text.] often occurs in several days to several years, causing an electric short-
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30 whisker occurs. However, lump-like protrusions occur, which are 10 times or more bigger than the diameter of a whisker.

 With solder plating, since the plating film consists of an alloy of lead and tin, it is necessary to maintain the
35 content ratio between lead and tin within a certain range, whereby it is necessary to maintain the composition of the plating solution within a certain range. However, since the composition of the plating solution changes as the plating process proceeds, it is necessary to constantly control the
40 composition of the plating solution, and there are other problems such as the plating solution being expensive.

 The present invention has been made to eliminate the drawbacks in the prior art as described above, and aims to
45 provide a method for preventing the occurrence of a tin

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whisker by applying an extremely thin layer of lead on the surface of a tin plating after ordinary tin plating has been provided, thereby providing effects equal to or greater than those which are provided by solder plating in terms of tin whisker prevention.

An example of the present invention will now be described. In Figure 3, (13) is a base metal, (12) is a base plating film, (11) is a tin plating film, and (31) is an extremely thin lead plating film provided on the tin plating film.

In the above-described example, a brass, with which an intrinsic whisker is likely to occur, was used as the base metal, and a tin plating solution containing a brightener, with which an intrinsic whisker is also likely to occur, was used for the tin plating, so as to produce a plating film having a thickness of 3 μm . Separately from this, a lead plating of 0.05-0.5 μm was provided on another tin plating film obtained under the same conditions. Among these plating films which were produced from a solution, an intrinsic whisker occurred in about one month on those for which only tin plating was provided. On the other hand, no intrinsic whisker occurred even after two years on those plating films for which a lead plating was provided on top of the tin plating. However, protrusions occurring on the solder plating film were observed. Where a lead plating was provided under a tin plating, rather than on top of the tin plating, the effect of lead plating was not seen, and an intrinsic whisker was observed as in the case of tin plating alone.

Thus, it was confirmed that there is an effect of preventing the occurrence of an intrinsic whisker when an extremely thin lead plating is present on a tin plating according to the present invention.

In another example, a lead film was produced on a tin plating to a thickness of 0.05, 0.1 and 0.3 μm by electroless plating vapor deposition, sputtering, etc. Also for these tin platings, it was confirmed that no intrinsic whisker* occurs even after about 1.5 years and that these tin platings have the same effects as those provided by the lead film formation through electroplating.

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Moreover, in still another example, a high lead concentration layer of 0.05 μm was produced on the surface of a tin plating film by ion implantation, wherein no intrinsic whisker occurred after about 1.5 years. It is noted that when a high lead concentration layer is formed by diffusion, heat is used and therefore there is a temperature increase, whereby a significant prevention effect is additionally provided from the temperature increase, and it is believed that an intrinsic whisker did not occur owing to a combination of the two prevention effects.

As described above, according to the present invention, a tin plating and a thin lead film are produced separately from each other, whereby the advantages of tin plating are not lost; the control of the plating solution is easier than in the case of solder plating; and it is not necessary to use an expensive plating solution such as a solder plating solution. Therefore, the present invention is extremely effective as a method for preventing the occurrence of a tin whisker.

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Agent: Shinichi KUZUNO